THE PRESENT STATUS OF MAHSEER (FISH) AND ARTIFICIAL PROPAGATION OF *TOR KHUDREE* (SYKES)

C. V. KULKARNI[1] AND S. N. OGALE[2]

(*With two plates and two text-figures*)

Mahseer has long been a great favourite of the anglers and also constitute an important fishery in north India. Six different species of Mahseer occur in India. However, the fishery has suffered a serious decline due to indiscriminate fishing of brood fish and juveniles by unjustifiable methods. Some of the handicaps in their natural multiplication are the long hatching period of 80 hours and a still longer duration of six days covering the semi-quiescent stage when the hatchlings remain clustered in corners and crevices and away from light. Heavy mortality takes place during this critical period. Hence, one of the methods to rehabilitate this group of fishes is to breed them artificially and distribute the fingerlings into natural waters. For this purpose, a system of catching the ripe brood fish from the spawning grounds, stripping them and fertilising the eggs was followed in the case of *Tor khudree* (Sykes) at Lonavla, Dist. Pune in Maharashtra. Large number of eggs were thus collected during breeding seasons (July-August) and hatched in running water. After the hatchlings pass through the quiescent stage, the fry are fed on zooplankton and then on artificial feed. They take about eight months to reach fingerling stage, suitable for stocking. A new method of transport of these eggs in moist cotton wool was tried and found successful.

INTRODUCTION

Mahseer, the noblest sport fish of India which had been a great favourite of most of the anglers, Indian as well as those hailing from distant countries the world over, is now feared to be in danger of extinction in some parts of the country. One ardent angler (M. L. Mehta) gave a vivid pen picture in the *Times of India*—(6-6-1976) of the wanton destruction of Mahseer in the rivers near Dehra Dun (U.P.) and appealed for a 'Save Mahseer' campaign.

The National Commission on Agriculture (1976), in its report on "Fisheries" stated "It has been reported that there has been a general decline in the mahseer fishery due to indiscriminate fishing of brood fish and juveniles and the adverse effects of river valley projects" and recommended "extensive survey and detailed ecological and biological investigations." These statements are significant, and necessitate remedial operations for conservation of this group of fishes which was at one time referred to as one species, the mahseer (*Barbus tor*). In the case of species from an aquatic environment, waiting for convincing proof of depletion may be dangerous as it may then be too late to retrieve. Methods of rehabilitation and conservation have therefore to be thought out in time and the same are attempted in the present article.

Although references will be made to different species of mahseer and their fishery status, the notes will deal largely with methods of artificial propagation of *Tor khudree* (Sykes)

[1] *Present address*: B/4, Shardashram, B. Shankar Road, Bombay 400 028.

[2] Tata's Electricity Office, Lonavla, Dist. Poona.

and transportation of its eggs packed in moist cotton.

Several species of the Mahseer exist, the principal ones being (1) *Tor putitora* (Ham.), (2) *Tor tor* (Ham.), (3) *Tor mosal* (Ham.), (4) *Tor khudree* (Sykes), (5) *T. mussullah* (Sykes). They have their own areas of natural distribution, ranging from the Lesser Himalayan region (Kashmir) to Darjeeling hills in the east, for the first species; the sub-Himalayan range, Ganga and Narmada river systems for the second; the Mahanadi basin (and also Burmese waters) for the third; the entire Peninsular India south of river Tapi for the fourth and the Peninsular rivers including Krishna and Godavari for the fifth. *T. khudree* has been reported from some parts of Narbada, North Gujarat, U.P. and Orissa also. Moreover, another large-scaled fish of Nepal and the eastern Himalayan range, the Katli or Bokar of Assam (*Acrossocheilus hexagonolepis* McClld.) is also included by anglers in this group and is designated as chocolate or red mahseer. *T. progeneius* (McClld.) of Assam and two sub-species, *T. mosal mahanadicus* (David) and *T. khudree malabaricus* (Jerdon) have also been reported.

Present status of the mahseer

Mahseers are well known sport fishes of rivers and streams in India and though their capture on a commercial scale must have been in practice in the past, only the catches made by anglers as a result of sport fishing have been recorded by some of the angler-authors. Sport fishing has shrunk considerably in recent years resulting in lesser competition, yet the reports of anglers are disappointing both in numbers and size (personal communication). The commercial fishery of putitor mahseer in Jammu, Himachal Pradesh and Uttar Pradesh consists largely of individuals either ascending streams for breeding or the spent ones returning to perennial pools in the plains (Sehgal 1972). Though exact numerical statements are wanting for proper comparison, whatever figures and reports of anglers are available, indicate considerable decline in the fishery (Sehgal, loc. cit.), especially of large ones. In Madhya Pradesh, particularly in the Narmada river near Hoshangabad and in Tapi near Barhanpur (Karamchandani *et al.* 1967) tor mahseer figured prominently in the commercial catches about 12 years ago but the landings are reported to have dwindled remarkably in recent years. In the lakes in Rajasthan as well as in the Chambal river between the Gandhi-Sagar and Rana Pratap Sagar reservoirs, the tor mahseer does occur in good numbers but their fishery status cannot be determined in the absence of previous catch data.

In Maharashtra also, the fish (*T. khudree*) has been practically a rarity in rivers Bhima, Krishna, Koyana, etc. except at a few temple sanctuaries at Dehu and Alandi on the Indrayani river and in some reservoirs. In the south also, the situation is in no way any brighter as regards occurrence of mahseers (*T. khudree* and *T. mussullah*). Kaveri (Cauvery) river which was at one time a home of large mahseers has been reported to be practically denuded of this anglers' delight and had to be stocked with fingerlings of the Deccan Mahseer *Tor khudree* (Sykes) from Lonavla (Maharashtra). A recent report appearing in the Deccan Herald (4-4-78), however, records a catch of 12 mahseers including a 92 pounder (42 kg) from Kaveri river, 100 km from Bangalore, by a British Trans-World Angling Team, but even this fish was caught only after an intensive effort for about $2\frac{1}{2}$ months by three experts.

Studies on the biology and angling capabilities of these species commenced with Thomas (1897), Khan (1939), Hora (1943), McDonald (1948), Nazir Ahmed (1948) and David (1953); but more intensive work on different species started only recently with the investigations conducted by Karamchandani *et al.* (1967), Kulkarni (1971), Desai (1972 and 1973), Tripathi (1978) and Das *et al.* (1978). Despite these studies, no steps for conservation and rehabilitation of mahseer have been taken so far on a sizable scale except in the lakes of the Tata Electric Companies at Lonavla (Maharashtra) and the efforts by the Wild Life Association of South India and the Karnatak Fisheries Department in cooperation with the above company.

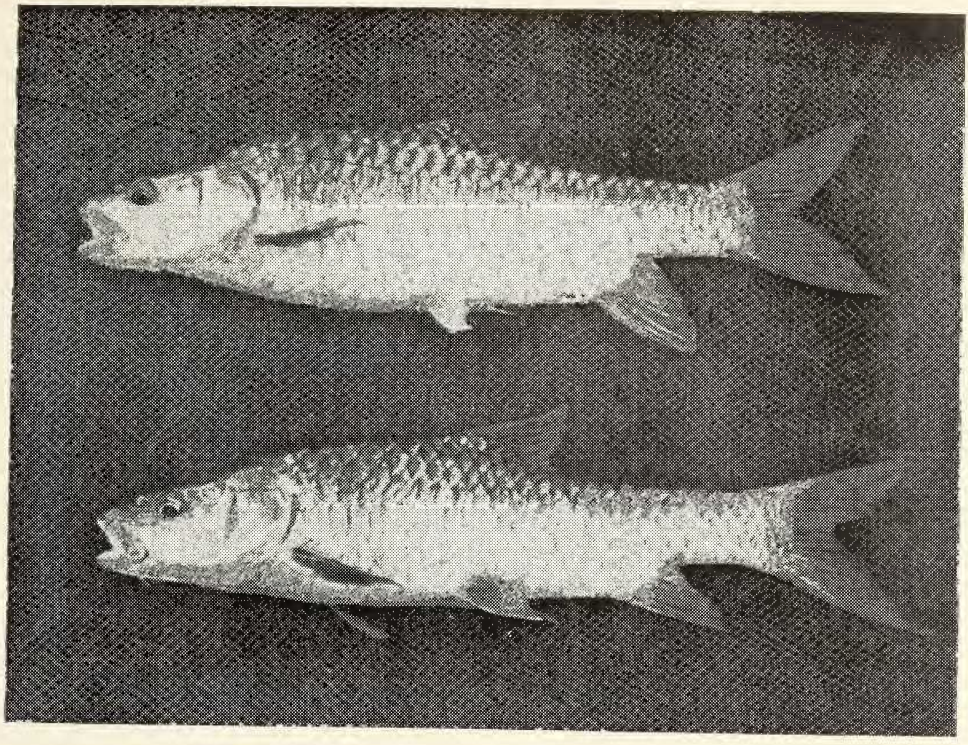
One of the main reasons for the decline of Mahseer, is the thoughtless destruction of this fish by illegal means such as the use of explosive and killing of brood fish in the spawning season. Another serious handicap the fish suffers from, is the change in the ecological condition of our riverine systems where several new multipurpose dams are being erected across numerous streams, large or small, all over the country. Such dams are no doubt, beneficial to the country in several ways; a number of large impoundments which would not have, otherwise, come into existence are created by these dams. This expansion of water bodies is advantageous to fish and fisheries in general but migratory fishes like Mahseer which used to visit clear water streams for breeding can no longer undertake those ascends unmolested, as human interference has penetrated into most of the previously secluded streams. It must, nevertheless, be admitted that Mahseer has, at many places, adapted itself admirably to life in the lacustrine conditions and manages to breed though on a small scale. These adverse circumstances reduce the chances of survival of Mahseer in large numbers in natural waters.

BIOLOGICAL CONSTRAINS IN NATURAL BREEDING

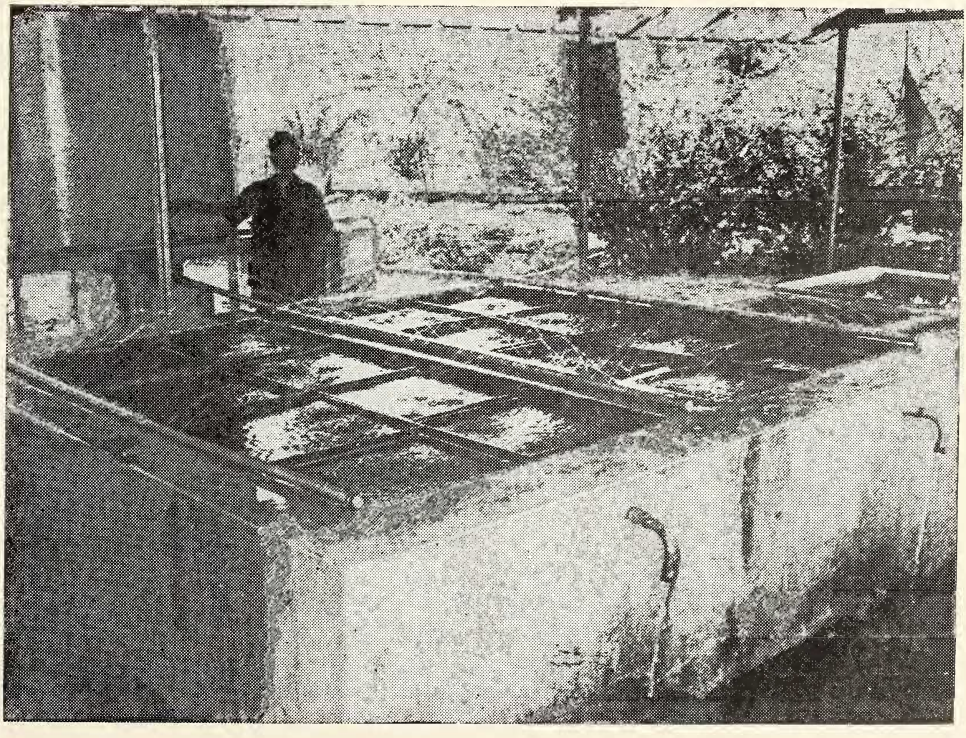
The Mahseer requires specialised biological conditions for its breeding and juvenile development. These were not clearly known so far. Observations on the early development and growth of hatchlings of *Tor khudree* made during past few years at Lonavla in Maharashtra (Kulkarni 1971) have focussed attention on the fact that this Mahseer (Photograph 1) suffers from several handicaps in its natural breeding. Firstly, its fecundity is comparatively low. Karamchandani *et al.* (1967) calculated fecundity of 30,420 ova for *Tor tor* of 625 mm in total length and Desai (1973) recorded 42,600 eggs for a 657 mm female of the same species; we have counted 20,000 ova from a 630 mm. *T. khudree* weighing 3.6 kg from one of the Lonavla Lakes. This is very low as compared to Catla (1,33,000 Av.) Rohu (2,61,000 Av.) per kg of body weight (Sukumaran 1969). Secondly, the hatching period is as long as 80 hours in water temperature of 22 to 26°C (Kulkarni, loc. cit.). This period is likely to be longer in colder streams of sub-himalayan region which the other species of Mahseer namely the *T. putitora* and the Katli Mahseer (*Accrossocheilus hexagonolepis*) inhabit. Further the semi-quiescent stage after hatching which is hardly 3 days in other carps is extended to as long as six days in *T. khudree*. During this period the hatchlings do not swim freely but remain at the bottom mostly huddled up in large numbers in corners and crevices with their heads tucked away from light, as if they are negatively phototropic, with their tails vibrating and jutting out (Fig. 2b). In this condition they are subject to depredation in large numbers by predatory animals. Thus this semi quiescent stage is the most critical stage of

their life and since it is prolonged, their mortality is also heavy. In all probability *T. putitora* and *T. tor* will have similar semi quiescent stage in their early life history, making them equally vulnerable to infantile mortality. In the past, the number of streams unfrequented by men was large and a greater number of mature mahseers had the opportunity to spawn unmolested and hence the critical quiescent stage in their life history did not matter very much. But with the increasing number of streams being used for reservoirs for multi-purpose development schemes, the traditional breeding grounds of the mahseers are lost to them. On top of this adverse situation, many of the streams which are excluded from the developmental activities, are affected by harmful industrial effluents which kill the fish fauna, and especially the tiny fry or the hatchlings in enormous numbers. All these handicaps combined together are working adversely on the fish fauna in general and on Mahseer in particular, because no effort has so far been directed towards rehabilitation or salvaging this group of fish, their specialised features in breeding and early development working against them. Hence, the only remedy to save them from this grave situation is to assist the fish in their critical stages by closely studying their breeding habits and by resorting to artificial method of propagation as is done in the case of the famous Salmon fishery in parts of north America and Europe where millions of fingerlings are raised by artificial methods and then released into natural waters. It is for this reason that methods of artificial propagation of this noble fish of India were studied and the details are given here under.

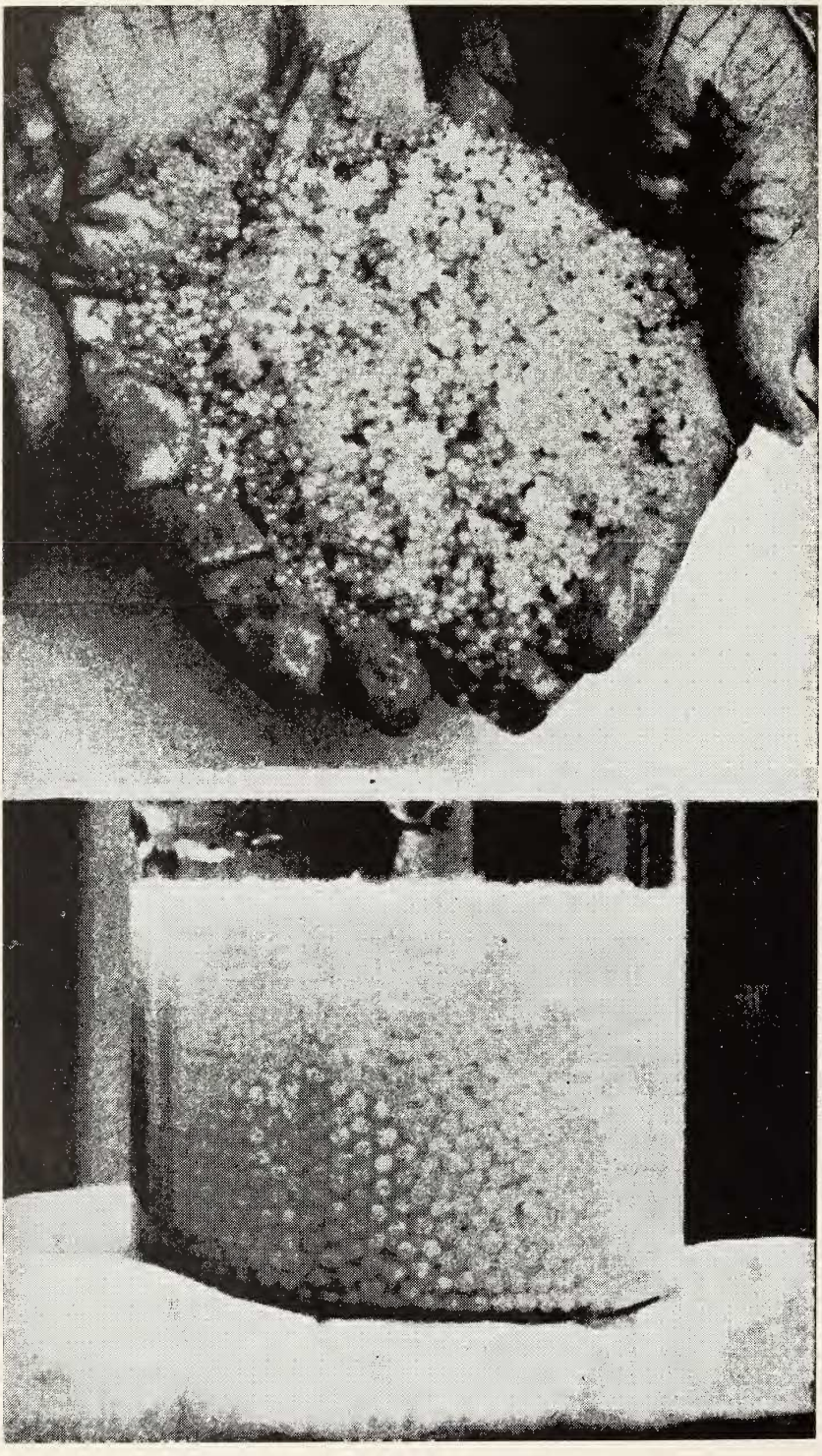
Breeding Habits: Different breeding seasons of different species of mahseers and in different climatic conditions described by several authors have been enumerated by the senior author (1971). Detailed biological study based on examination of a large number of specimens obtained from the commercial catches of mahseer from the Narbada river in Madhya Pradesh was undertaken by Karamchandani *et al.* (loc. cit.). The examination of ovarian eggs and their maximum sizes in different months enabled them to conclude that the breeding season of *Tor tor* commences in July or August and continues upto December, the peak season being from July to September. Their observations tally, to some extent, with those made at Lonavla, except that the length of the spawning season is not as long as recorded by Karamchandani *et al.* (loc. cit.). Even the peak of the season is not long enough at Lonavla, being only mid-July to mid-August, where the spawning season was determined not on the basis of maximum diameter of ova found in the specimens examined, as was done by Karamchandani *et al.*, but on actual collection of brood fish in real ripe condition, stripping of eggs and their fertilisation. In this respect, Codrinton's (1946) statement that 'major spawning period of Mahseer is in August largely agrees with the observations made at Lonavla. Record of eggs collected and fertilised at Lonavla during past eight years is as under:—



Deccan Mahseer (*Tor khudree*) Female, above; Male, below.



Hatchery Tank with water being sprayed on the hatching trays.
(*Photos*: Author)



Above : Eggs of Mahseer.
Below: Eggs of Mahseer in water. (Photos: *A. V. Shukla*)

Time	1971	1972	1973	1974	1975	1976	1977	1978
July 1st Week								
July 2nd Week			5,700	36,000	19,800	63,000		1,12,800
July 3rd Week	14,000	21,500	30,900	14,600	23,400	92,400	1,00,200	1,08,800
July 4th Week	3,000	200	25,600	24,300	14,200	22,000	1,25,800	71,700
Aug. 1st Week			28,200		1,13,400	1,44,000	98,100	1,79,900
Aug. 2nd Week	13,000		24,200	1,64,600	50,000		91,900	—
Aug. 3rd Week	24,500	87,400	90,800	32,800		17,000	—	75,800
Aug. 4th Week		24,000	6,000					—
Sept. 1st Week	22,000		16,200					14,000
Sept. 2nd Week			6,600					
Sept. 3rd Week								

This record will indicate that peak period of breeding when the largest number of eggs was consistently available was in August except in 1977 and 1978 when there was heavy rain in late July. Incidentally, the above records corroborates a similar forecast made earlier by the senior author (1971). It was seen that heavy collection of eggs usually coincided with heavy downpour of rain causing the streams adjoinning the lakes to swell and debouch large quantities of fresh rain water into the lakes.

Artificial propagation:

As is common with most of the cultivable species of carps, breeding of Mahseer with pituitary hormones was attempted but with limited success. This does not preclude the use of this method for artificial propagation. In fact, where the natural spawning grounds are difficult to locate, this would be the only solution. But its success would depend on the ecological conditions of the stocking ponds, the available food and the availability of sufficient stock of healthy and ripe brood fish. In Nainital hills (U.P.) stripping of ripe *T. putitora* (Ham.) was attempted in 1976 and eggs fertilised but heavy mortality during development was reported (Tripathi, loc. cit). However, our experience since 1970 indicated that if fishery biologists can locate the probable spawning grounds of Mahseer and can determine the peak of the spawning period with certain amount of exactitude so as to collect the ripe brood fish the stripping and fertilising the eggs artificially was more dependable. This latter procedure was followed in two lakes near Lonavla (Pune Dist.) namely Walwhan and Shirawta (*c.* 18°.45′ to 18°.40′N and 73°.25′ to 73°.29′E). They are respectively about 6.14 and 13.10 sq. km in area and 20 to 30 m deep. They are surrounded by hills all round and their source of supply is the seasonal streams flowing through the adjoining hills. The hills being steep and small, the flow continued only when heavy showers prevailed. The brood fish were observed to congregate at a short distance near the inflow of these temporary streams into the lakes. It was also observed that ripe fish congregated more during early part of the night say between 7 and 10 p.m. and again from 4 to 6 a.m. Netting operations undertaken during intervening period were comparatively less fruitful. Splashing of water or any nuptial play was rarely seen. In fact, actual natural egg laying (spawning) and fertilisation has not been seen except the reports of some observers, who describe the embra-

cing act being similar to that of Rohu but in clear water and below the surface.

For the purpose of breeding operations, the spawning grounds are visited when it is raining and the streams are running. Suitable gill nets usually of 15 cm extended mesh are laid at 6 p.m. and hauled at 11 p.m. and 4 a.m. Ripe males and females, their ripeness judged by presence of milt in the male and soft bulged abdomen in the female are freed from the net by cutting some of the meshes. Other sex-determining characters are the peculiar obliquely protruding base of the anal fin of the female out of the curve of the ventral profile and the length of the pectoral fin in the male which have been detailed earlier (Kulkarni 1971). If the female is in the correct stage of ripeness, some eggs can also be seen extruding on slight pressure on the abdomen. Such ripe females are then stripped by the conventional method (dry process) in a suitable enamel tray and the eggs fertilised by the milt similarly obtained from the male. After two or three minutes, the excess milt is washed by adding and changing the water in the tray. The eggs have a tendency to stick to the surface of the tray but they can be carefully detached with the help of cotton wool and slight pressure. Water of the trays is then changed every half an hour and the eggs allowed to harden for next four hours. Thereafter they are placed in wooden trays, with plastic netting at the bottom and wooden sides (Fig. 2a). They are usually 55 × 35 × 12 cm high and are kept floating in a cement hatchery tank (photo 2) usually 2 × 1 × 1 m high (fig. 1). Each tray can accommodate about 30,000 eggs and being demersal they remain well arranged on the plastic netting about 4 cm below the surface of water. Clean tank water is continuously sprinkled over the eggs through perforated pipes running on the sides of the tank wall (fig. 1). Dead eggs, if any, are picked off with a pipette and the eggs kept clean. Excess water of the hatching tank overflows through a pipe having its opening (mouth) at the bottom by a siphon system, thus ensuring removal of less oxygenated bottom water. The eggs are thus bathed in well oxygenated water almost continuously although no harm is expected if the water is stopped intermittantly.

As mentioned earlier, it takes about 80 hours for the eggs to hatch out in water of about 22° to 26°C. temperature, the hatchlings remain in semi-quiescent stage for almost six days. This critical stage has also been highlighted earlier. The eggs which are bright lemon yellow or orange in colouration and measure 2.8 to 3.00 mm in dia. have already been described by the senior author (1971) along with other larval and post-larval stages. On the seventh day the fry swim freely (Fig. 2c) and start feeding on minute zooplankters like *Moina, Daphnia,* etc. After a day or two they start taking powdered groundnut cake and rice polish in small quantities. They are then shifted to cement nursery tanks and fed on zoo plankton as well as the artificial feed (groundnut cake) soaked in water. After making them accustomed to artificial feeding for about three or four weeks they are released into earthen nursery tanks for further growth. At this stage, the fry are about 30-35 mm in length and are suitable for transport over long distances in plastic bags in water and oxygen. Such consignments sent from Bombay to Bangalore showed no mortality. In about six to eight months the fry reach the stage of fingerlings and become suitable for stocking into perennial lakes or streams.

Transport of eggs in moist cotton:

As one of the measures to facilitate propagation of Mahseers into distant areas within

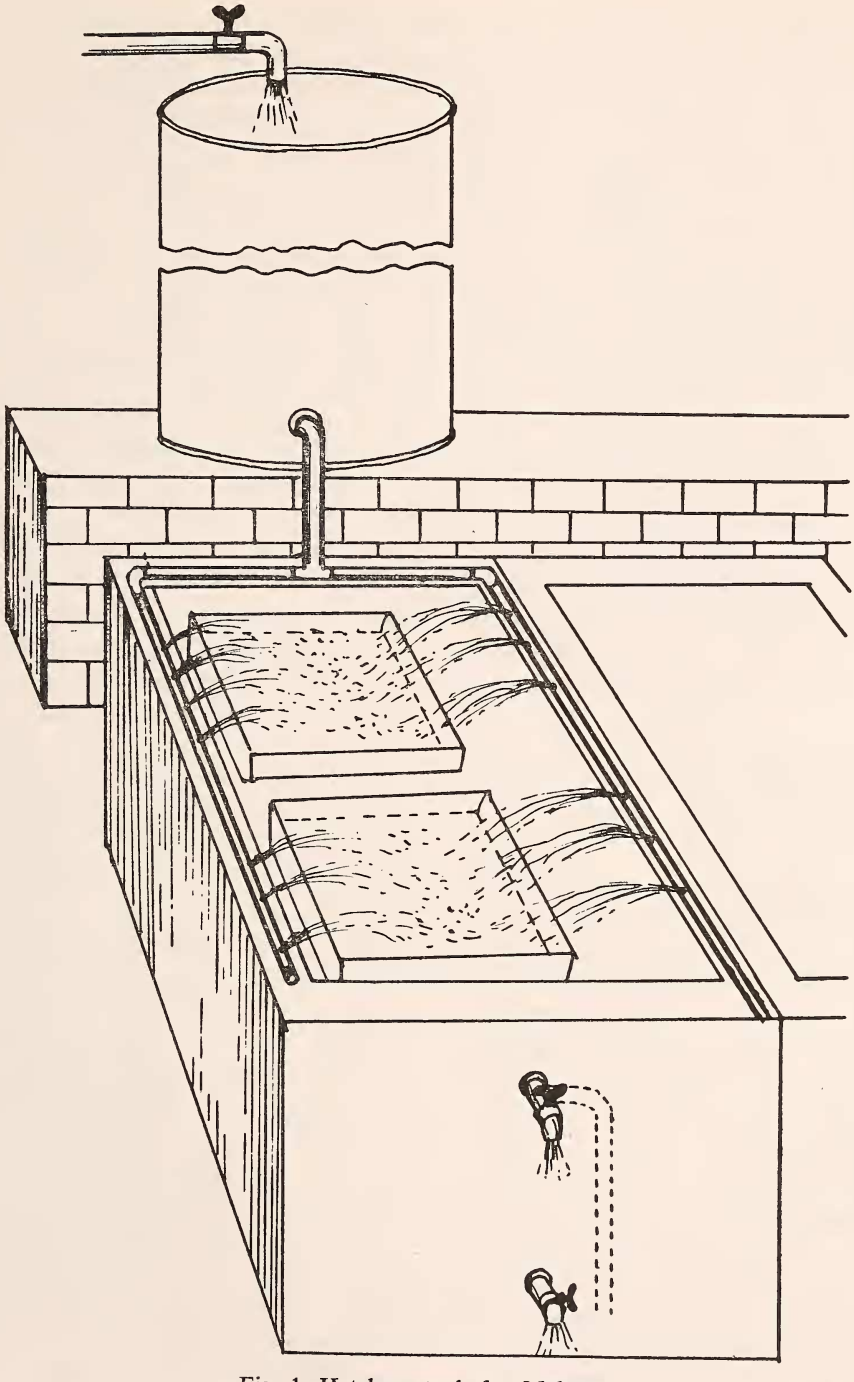


Fig. 1. Hatchery tank for Mahseer.

the country and abroad, an effort was made to pack fertilised eggs in moist cotton to ascertain whether they would remain viable, the idea underlying the experiment was to see whether they can be transported without water. Transport of "eyed ova" (fertilised eggs) of trout even across continents for their propagation in new environments is a well known practice and it is in this manner only that trout has been introduced in Kashmir, Nilgiris, Sri Lanka and many other countries. However, such effort has not been made so far with eggs of any of our other Indian fishes. This is probably because the hatching period in most of our common fishes is of short duration and the eggs are comparatively delicate.

To achieve the aforesaid objective of keeping eggs out of water, in moist packing, a small tray was selected and its bottom covered with moist cotton wool. About 40 eggs fertilised by the usual stripping method and water hardened from 6 to 24 hours were placed on moist cotton wool and covered by a layer of similar type of cotton. The tray (Fig. 2d) was kept in a laboratory room (air temp. 22°C) and after 24 and 48 hours they were taken out, released into water and hatched normally. Results of these experiments conducted in August 1977 were as under:

Batch No.	Period of water hardening	No. of eggs.	Period in tray	No. of hatchlings obtained.
I	12 Hrs.	30	12 Hrs.	26
II	6 Hrs.	40	24 Hrs.	36
III	6 Hrs.	40	48 Hrs.	37
IV	24 Hrs.	30	36 Hrs.	26

Observations in Batch II and III above are fairly satisfactory. The small variation in the number of hatchlings obtained in these batches after 24 and 48 hours may be due to the condition of eggs at the time of fertilisation or other factors commonly prevalent during the process of hatching which is as long as 80 hours. It is, nevertheless, significant that increase of period from 24 to 48 hours had no adverse effect on the number of hatchlings obtained, and indicated that 48 hour period was equally safe. Moreover, six hours seems to be an ideal period for hardening of eggs. but the longer period of 12 and 24 hours gave an opportunity to weed out unfertilised or damaged eggs, if any. Leaving aside the small variation, the results prove that eggs are capable of being kept in moist cotton and remain viable for at least 48 hours. As a field trial, two consignments, each of 5000 eggs were taken to Bombay Air Port from Lonavla, a distance of 100 km and parcelled by Air Bus to Bangalore unattended, in August 1978. They were packed in two layers of moist cotton in plastic baskets with an outer container of tin. In the first consignment mortality of eggs reached 8% upto Bangalore air port, whereas in the second, the mortality came down to mere 1.5%. About 75% of these eggs hatched out successfully. This experiment is the first of its kind in India and opens up new possibilities of transport of fertilised eggs, instead of fry, by air and then hatching them in the usual manner, thereby saving considerable expenses on transport in containers with water.

Further, if this method of packing of eggs is possible in the case of *Tor khudree,* there is no reason why it should not succeed in the case of *T. tor, T. putitora, T. mosal* and others. It is desirable that efforts should be made in their case also. If these experiments succeed, possibilities of exporting mahseer eggs to foreign countries which need them for purpose of culturing them as sport fish, can be ascertained and our esteemed Mahseer can have new homes outside India.